Enabling Scientific and Technological Improvements to Meet Core Partner Service Requirements in Alaska - An Arctic Test Bed

Carven A Scott
NOAA/NWS Alaska Region Headquarters
Chief, Environmental and Scientific Services Division

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Abstract

Test beds, such as the Joint Hurricane Test Bed (Miami, FL) and the Hazardous Weather Test Bed (Norman, OK) have been highly effective in meeting unique or pressing science and service challenges for the NWS. NWS Alaska Region leadership has developed plans for a significant enhancement to our operational capabilities in Alaska to address the emerging requirements of the Arctic: An Arctic Test Bed.

Historically, the complexity of forecast operations and the inherent challenges in Alaska have not been addressed well by the R&D programs and projects that support the CONUS regions of the NWS. In addition, there are science and technology, and unique service challenges (e.g., sea ice forecasts) and opportunities (Bilateral agreements with Canada, Russia, and Norway) that would best be worked through Alaska operations. A dedicated test bed will provide a mechanism to transfer technology, research, and observations advances into operations in a timely and effective manner.

A NOAA Arctic Test Bed will provide a crucial nexus for ensuring NOAA's developers understand Alaska's needs, improve NOAA's responsiveness to its Arctic-related science and service priorities among the NWS and OAR (CPO and ESRL), and enable better leveraging of other research initiatives and data sources external to NOAA which are particular to the polar region (e.g., WWRP Polar Prediction Project).

NOAA Arctic Test Bed Overarching Consideration

The United States is an Arctic nation, one of only eight such nations worldwide that are responsible for the stewardship of a region undergoing dramatic environmental, social, and economic changes. (*Managing for the Future in a Rapidly Changing Arctic: A Report to the President*)

NOAA Arctic Test Bed Organizational Gap

According to the NAPA report:

- *Internal and external NWS stakeholders expressed the view that efforts to improve O2R-R2O should be done in a way that would not stifle innovation. The R2O-O2R process would be cohesive, include adequate resourcing not only in research activities, but also define the steps needed to transition research results into the operational environment.*
- *NWS is encouraged to become a better, more agile organization.*
- *NWS needs an advisory committee that is focused on weather related issues and includes stakeholders from across the weather enterprise, core partners, and physical and social scientists will be better positioned to assist the NWS.*
- *Test Beds allow for quick implementation of new products and services where those closest to the customer needs have the best opportunity to discover requirements and innovate.*

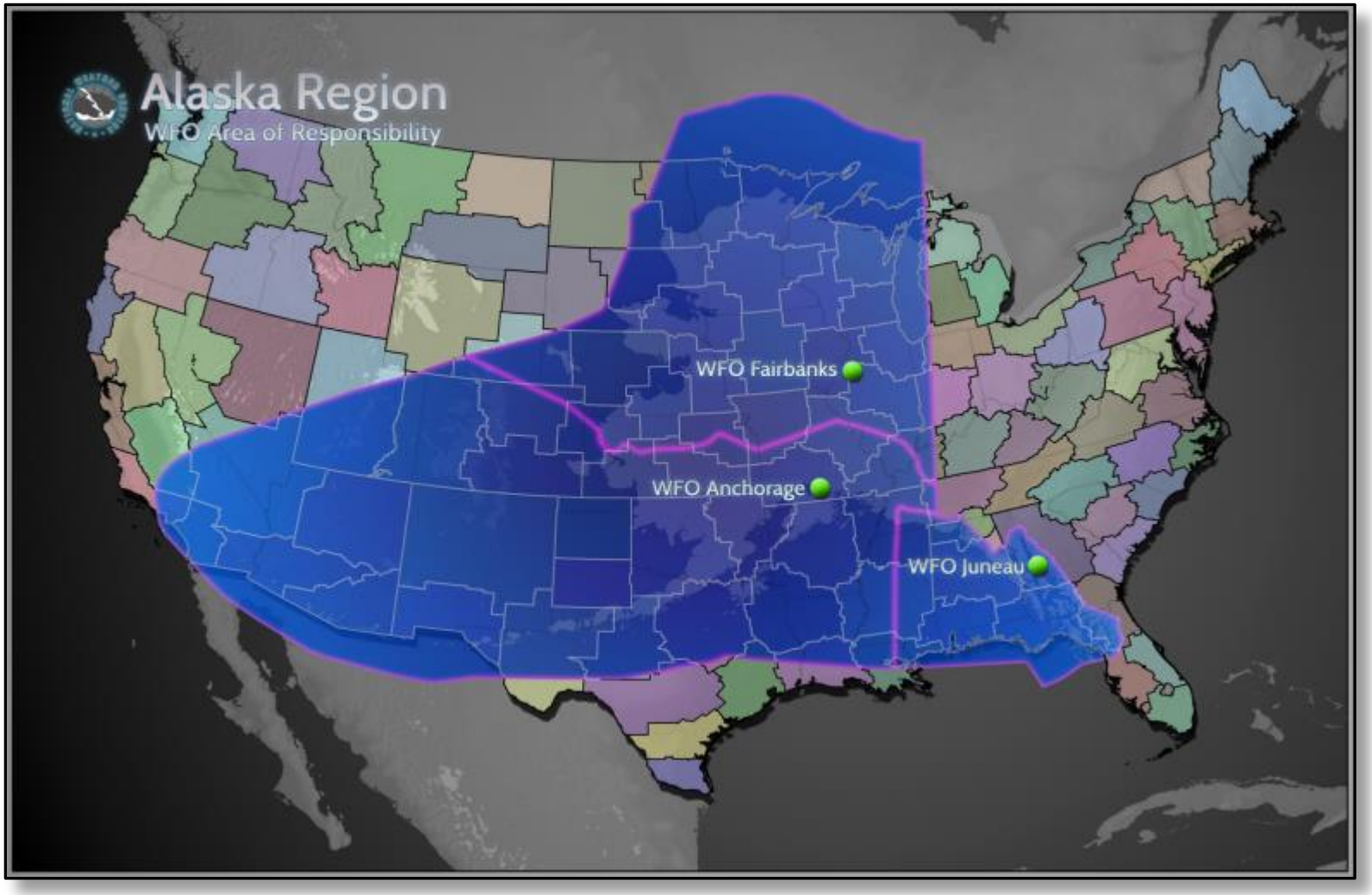
NOAA Arctic Test Bed Organizational Gap

According to the NOAA Blue Book:

- *NESDIS (GOES-R and JPSS programs) received an increase in funding directly linked to improvements in satellite information which leads to improved observational platforms to enhance products and services throughout the government.*

NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

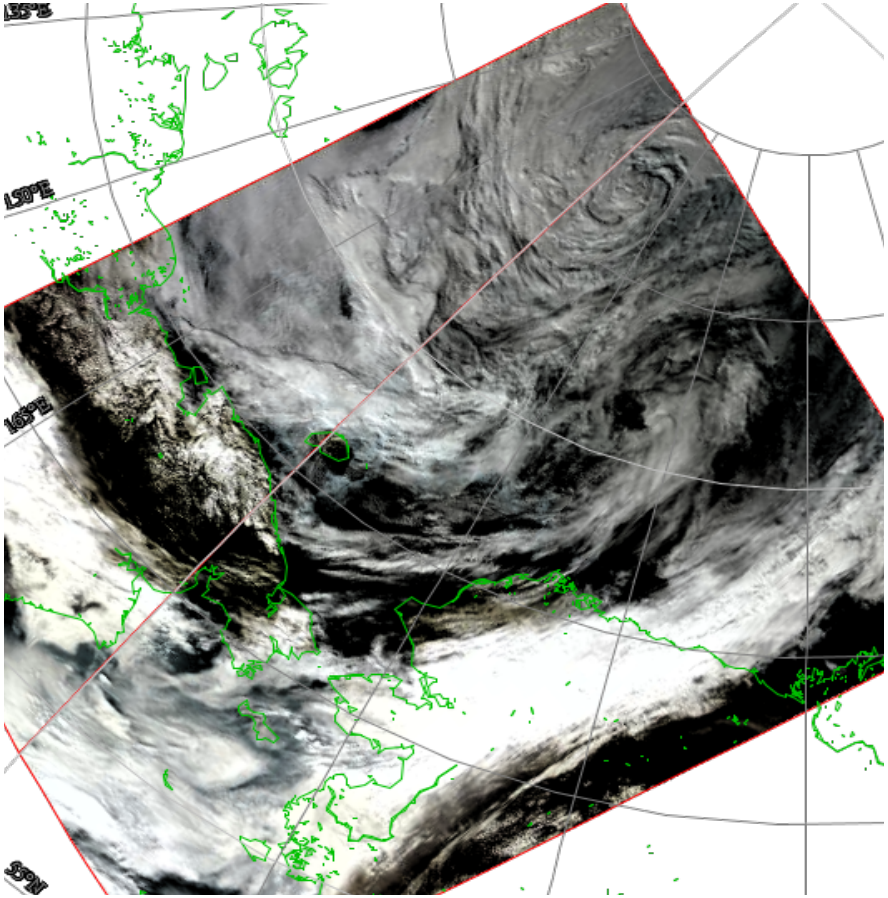


NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

Arctic Summer "Hurricane" August 2012

- One of the strongest summer storms to have affected the Arctic Ocean in recent decades occurred in early August.
- The storm's central pressure was comparable to a Category-1 hurricane.
- The storm dispersed an already sparse ice cover, and waves from the storm propagated through the open water to the northern Alaskan coast, producing flooding in some villages.



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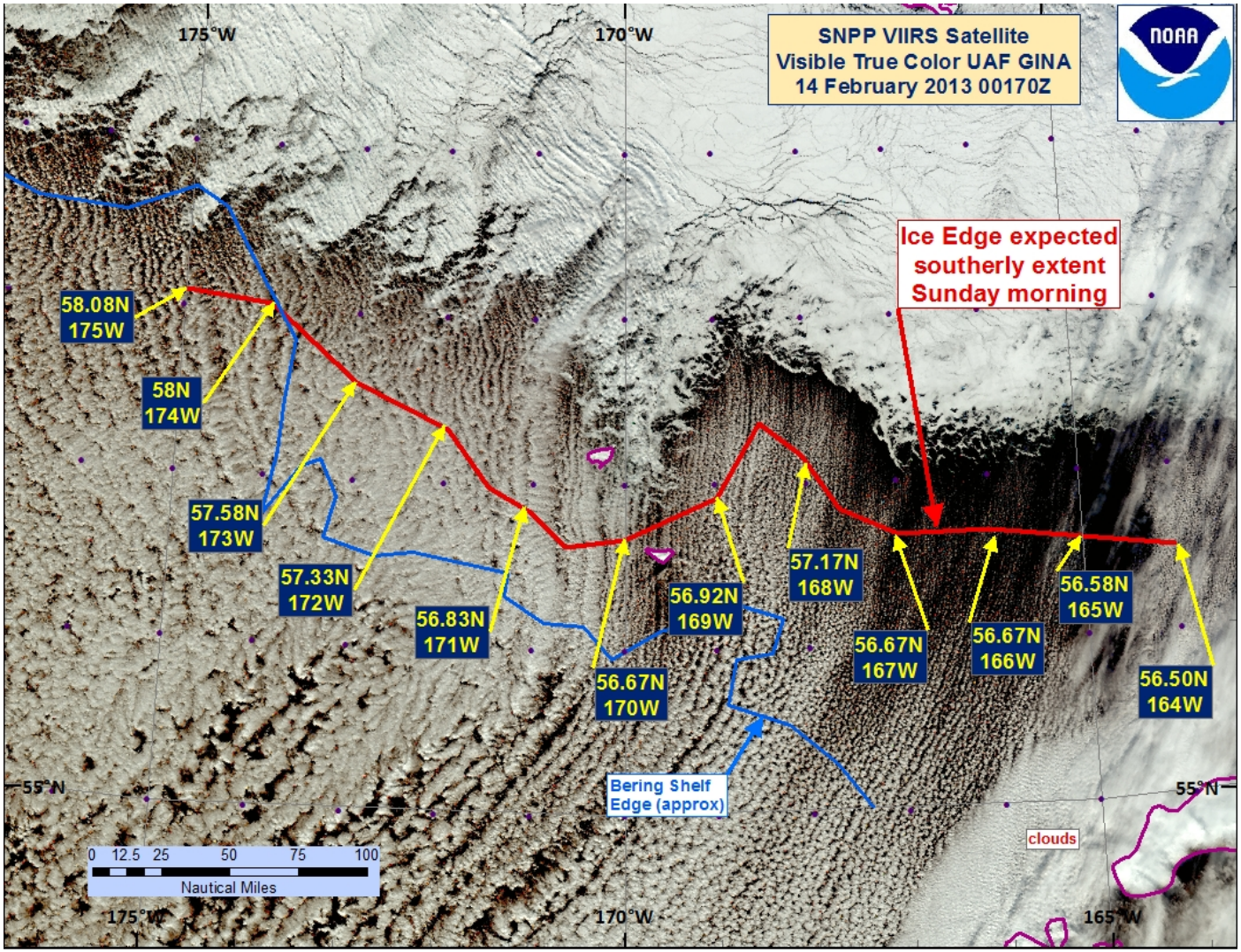
Forecast Challenges and Limited Resources

"The Deadliest Catch"



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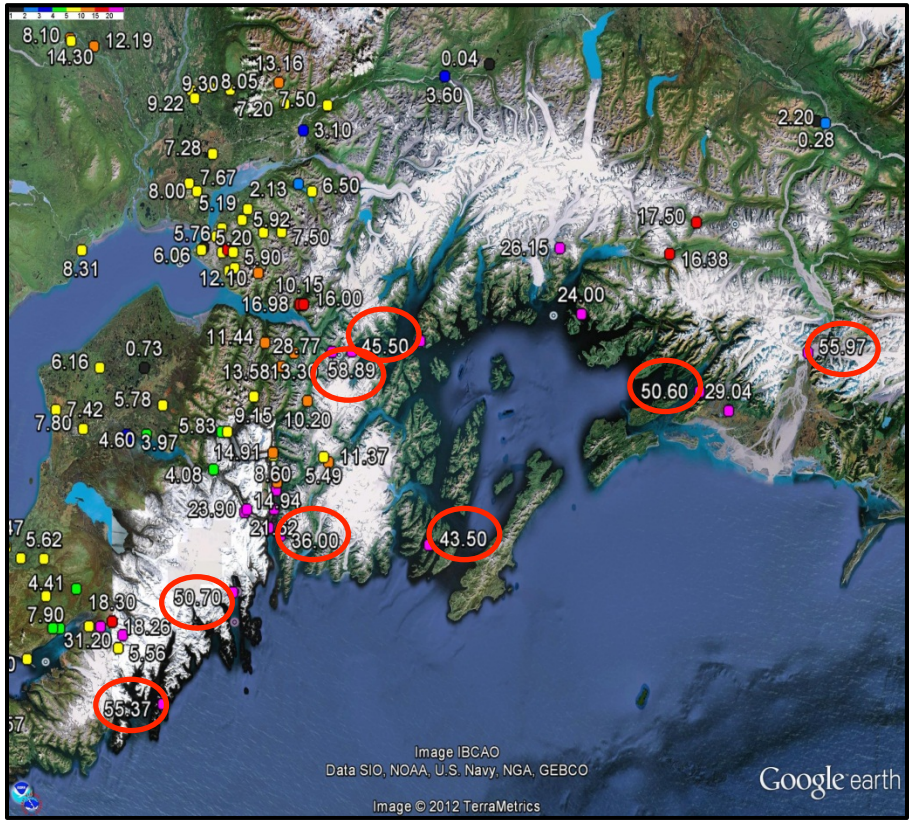
Forecast Challenges and Limited Resources

Atmospheric River September 2012 Alaska



* Storm Track over Central Alaska for almost four weeks.
* Record monthly river stage heights and flooding.
* Over $35M in damage to homes and infrastructure.
* Unofficial wind gusts to 130 mph recorded in the Anchorage area with 70 to 90 mph common elsewhere in South Central Alaska.
* Record rainfall and stage height across much of South Central Alaska.

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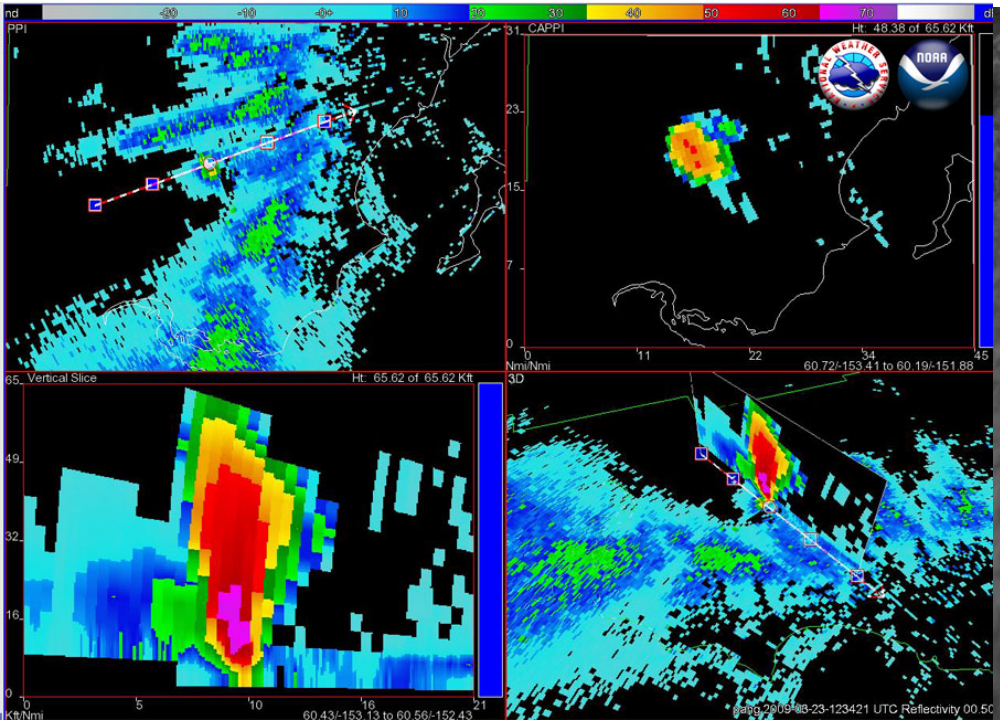
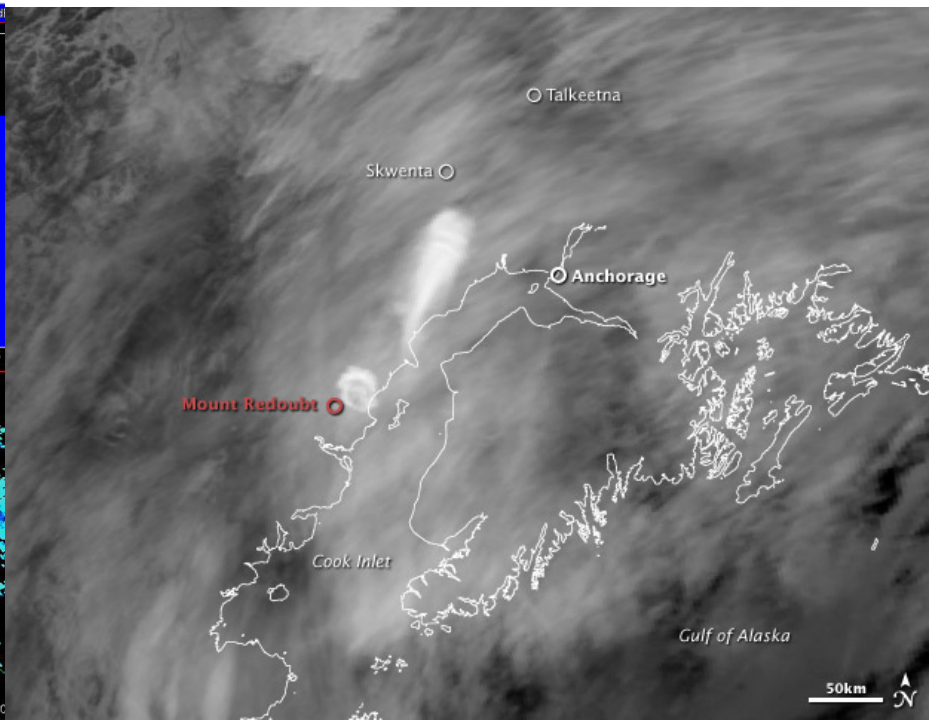
Forecast Challenges and Limited Resources

Volcanic Ash (Mt Redoubt 2009)





Kenai WSR-88D (PAHG)

Terra-MODIS IR

Approximately12:30AM AST March 23, 2009

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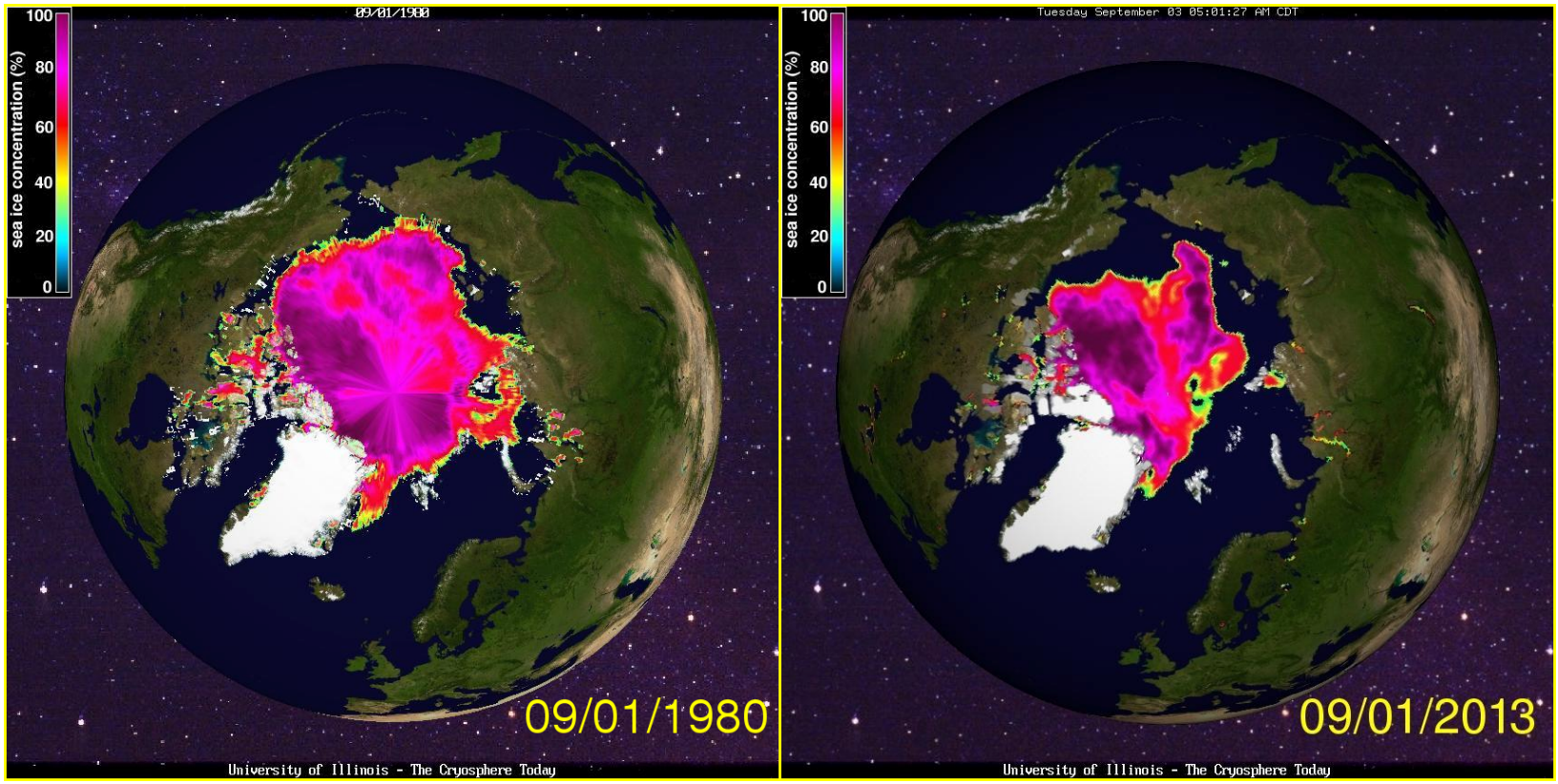
Forecast Challenges and Limited Resources

Arctic Sea Ice



September 1, 1980 September 1, 2013

The loss of sea ice and the extreme variability in freeze-up and melt dates affect marine access, regional weather, global climate, marine and terrestrial ecosystems, and coastal communities.

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Forecast Challenges and Limited Resources

Coastal Erosion due to Lack of Sea Ice
near Barrow in October

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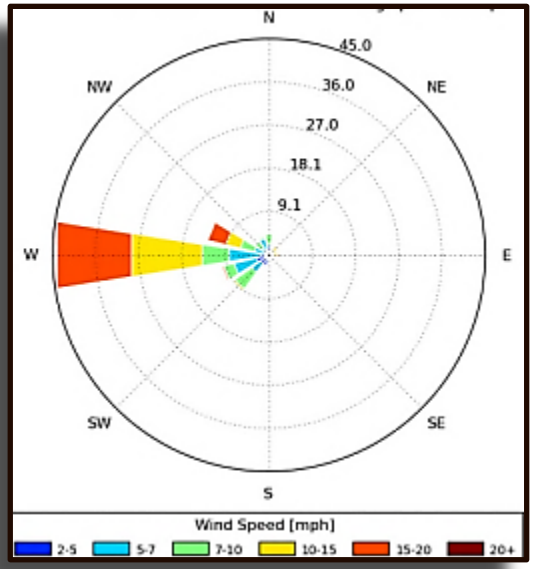
Forecast Challenges and Limited Resources

Sea Ice Damage Kotzebue May 2011

May 28 – Jun 2, 2011
Windrose Kotzebue, AK



May 27, 2011 - Shorefast locked in place

May 31, 2011 - Melting ice on the move from wind & tides

Ice Breakup in Kotzebue can turn damaging when winds combined with high tide push ice onshore

Damage can occur with normal tides and west or northwest winds of 10 to 20 mph.

Similar threats across the Arctic

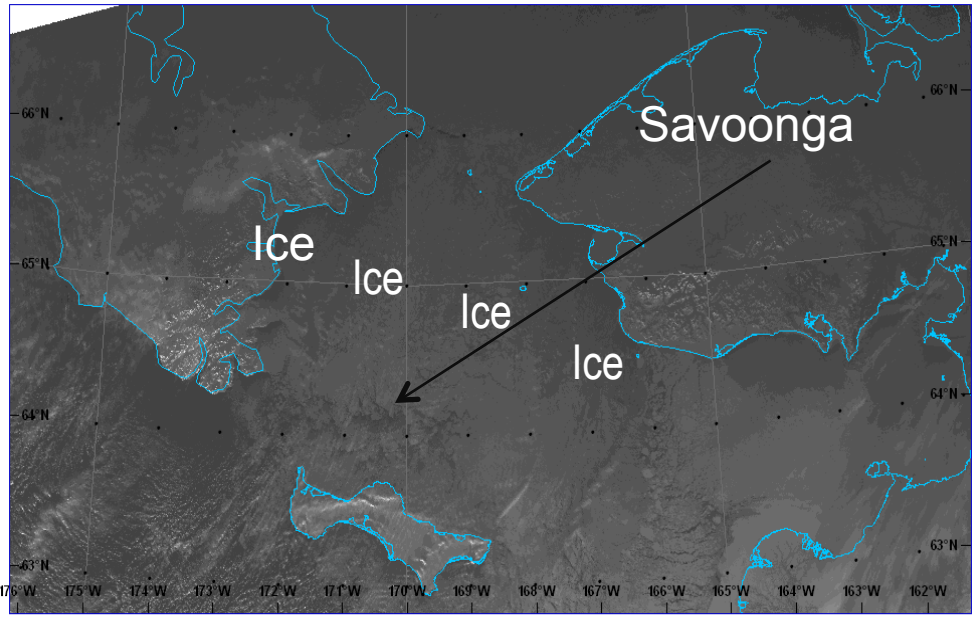
May 30, 2011 - Sea ice damages structures in Kotzebue, AK

NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

Power Outage Savoonga Dec 26 2010 to Jan 3, 2011

- Intermittent power outage for 6 days
- Temperatures ranging from 5F to -10F with 30-50 mph winds
- Nearly ¾ of residents lost power
- 25-30 homes experienced bursting pipes and flooding
- At least 20% of the 700 village residents sought refuge in the school (on generator)
- Weather hindered the ability to send in food, plumbing supplies, and repairmen



"The **extreme cold caused the salt spray to freeze on electrical equipment**. Initial outages were caused by line slap from iced-up conductors, but later problems were caused by electrical arcing through conductive salt. We are concluding that the **lack of sea ice was a major contributor to this situation**."

-Meera Kohler, Alaska Village Electric Cooperative

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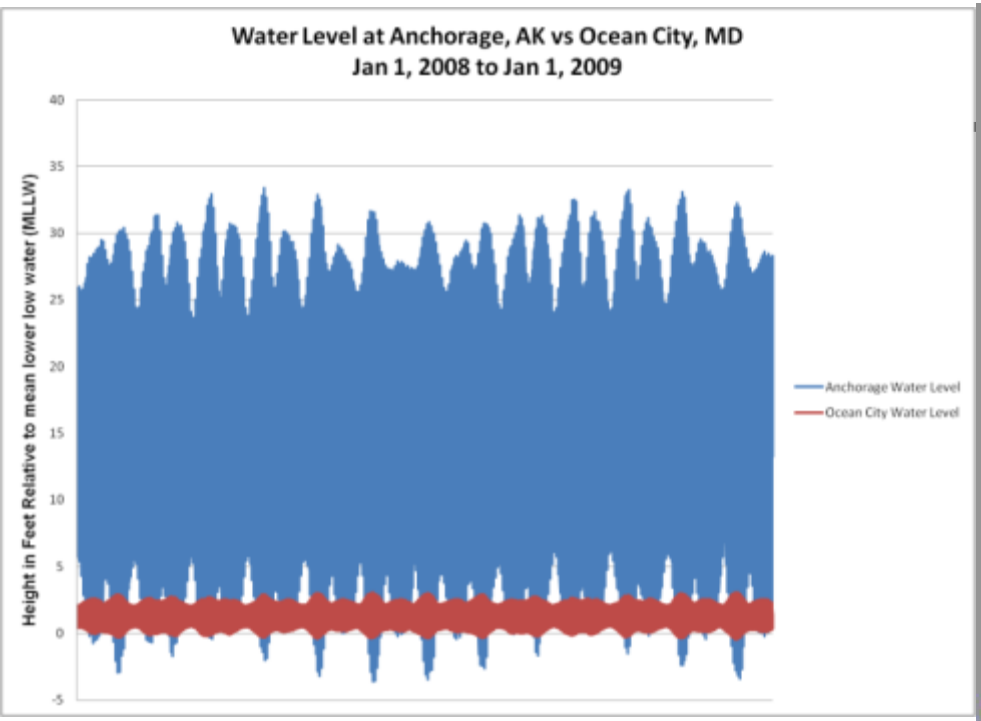
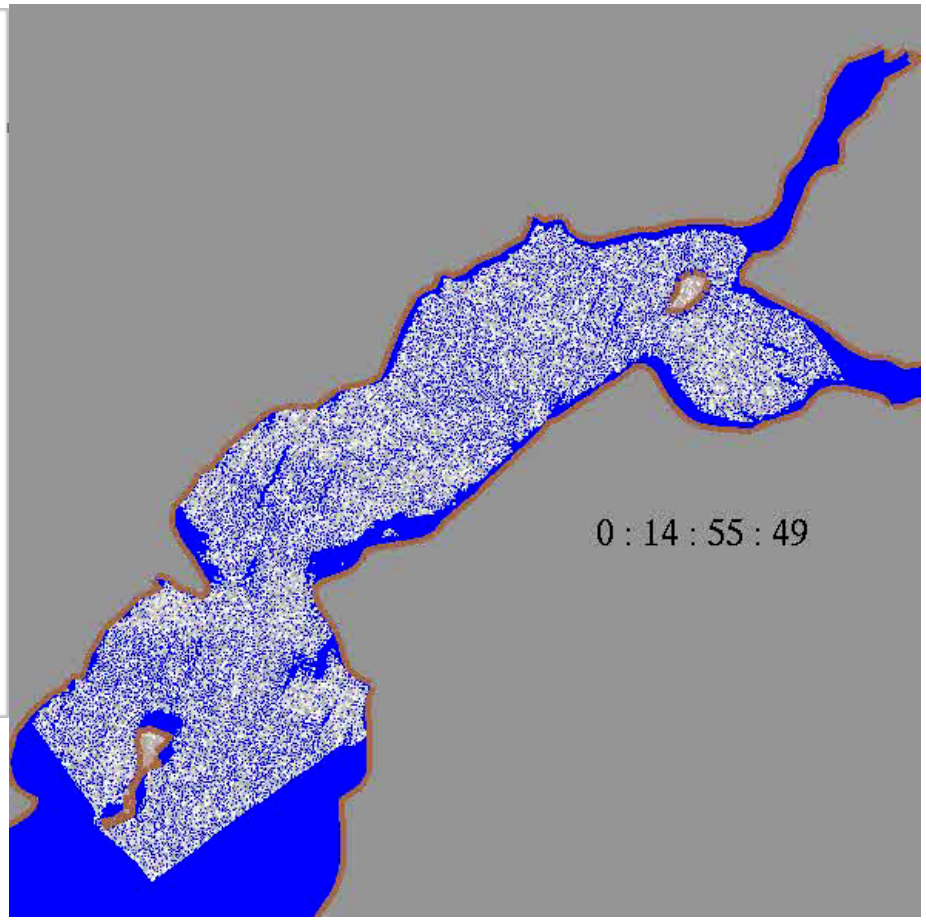
Forecast Challenges and Limited Resources

Sea Ice and Tides

Tides Influence Concentration and Movement of Sea Ice





Critical to the Alaska Supply Chain Management

NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

Sea Ice and Tides

Ship Loose from Mooring in Cook Inlet due to tide and ice interaction.

NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

Sea Ice and the Alaska Fishing Industry

Freezing Spray, accumulated beyond the ice edge

Fishing for Ophelia Crab in the Bering Sea

The combined value of Alaska seafood exports and the retail value of Alaska seafood sold in the U.S. totaled an estimated $6.4 billion. The Alaska seafood industry directly employed 63,100 workers in Alaska, making it the state's largest private sector employer. Total direct and secondary economic output in the U.S. stemming from the Alaska seafood industry was estimated at $15.7 billion.

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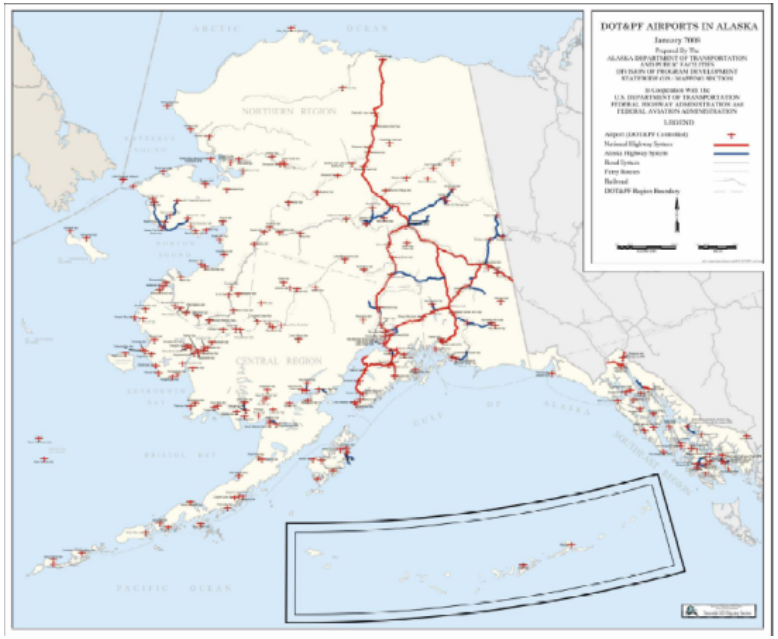
Forecast Challenges and Limited Resources

Resupply and Supply Chain Management

USCG Healy escorted Tanker Renda to resupply Nome, AK and surrounding villages with fuel for the winter. (Dec 2011 – Jan 2012) through over 400 miles of Bering Sea ice



Fuel and food for rural Alaska

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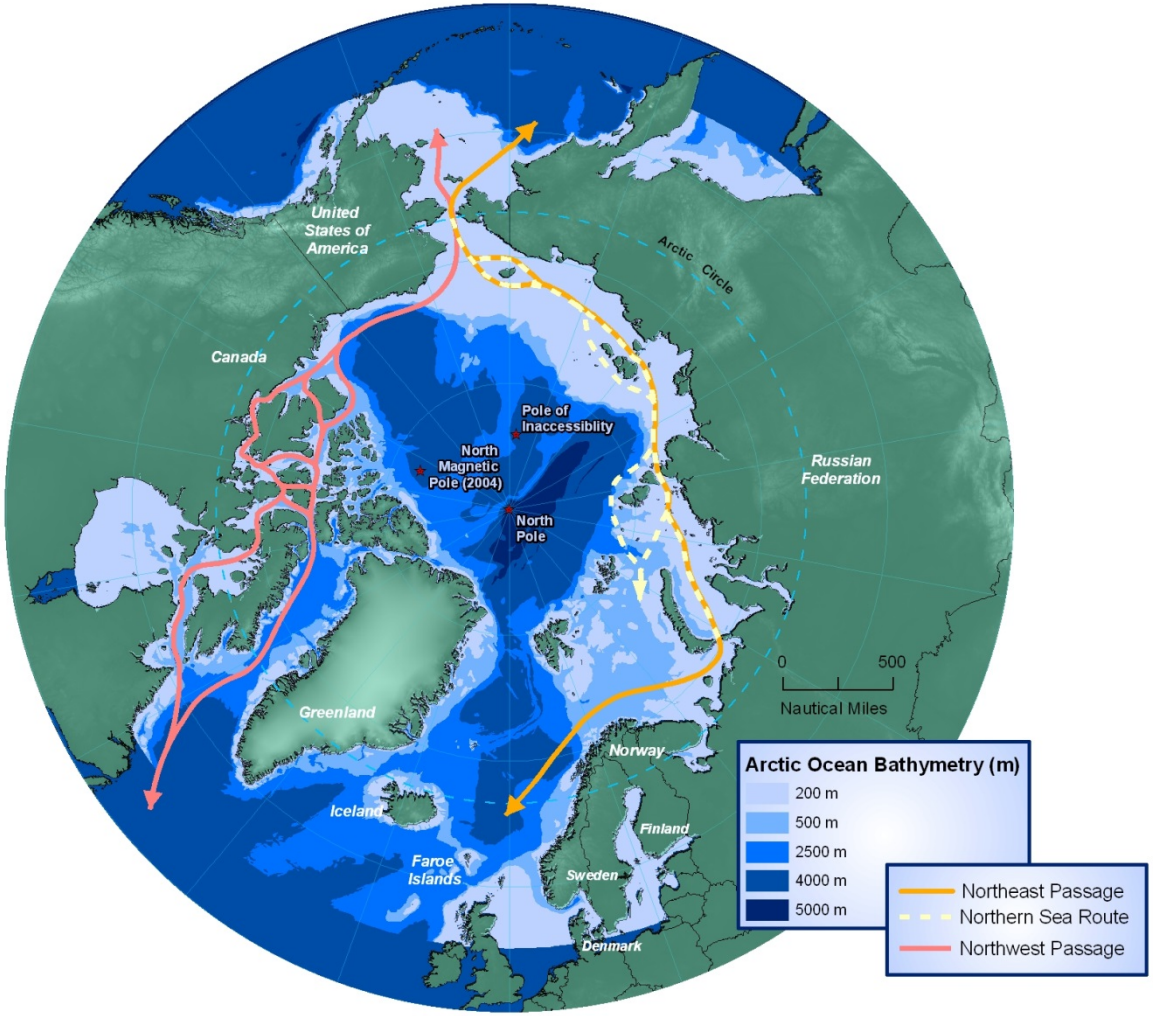
Forecast Challenges and Limited Resources

Arctic Marine Transport Modes

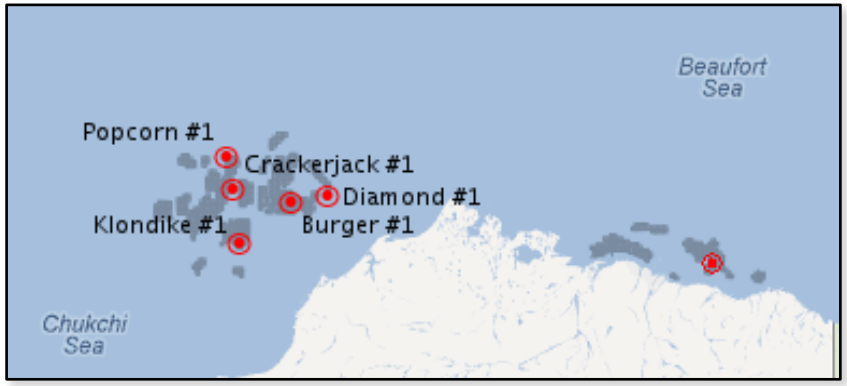


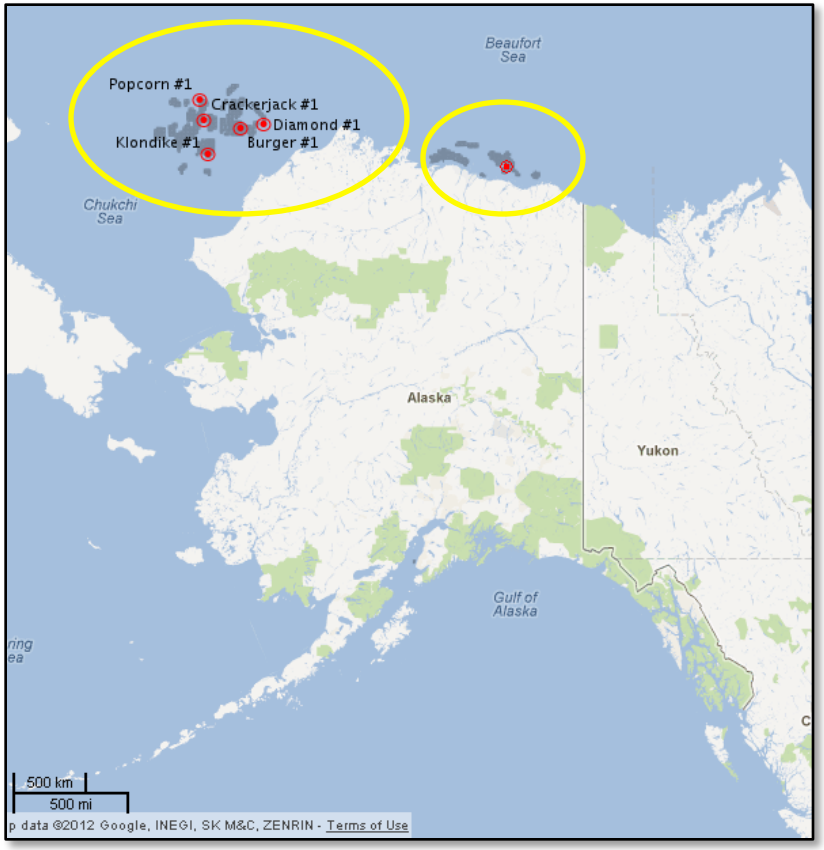
NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

Decision Support in the Arctic

- In Early September 2012, Department of Interior (DOI)/Bureau of Energy Management (BOEM) requested NOAA support:
  - To provide our best forecast for freeze-up at the Burger drill site
  - To provide weekly updates to the initial ice forecast and weather conditions of significance to operations





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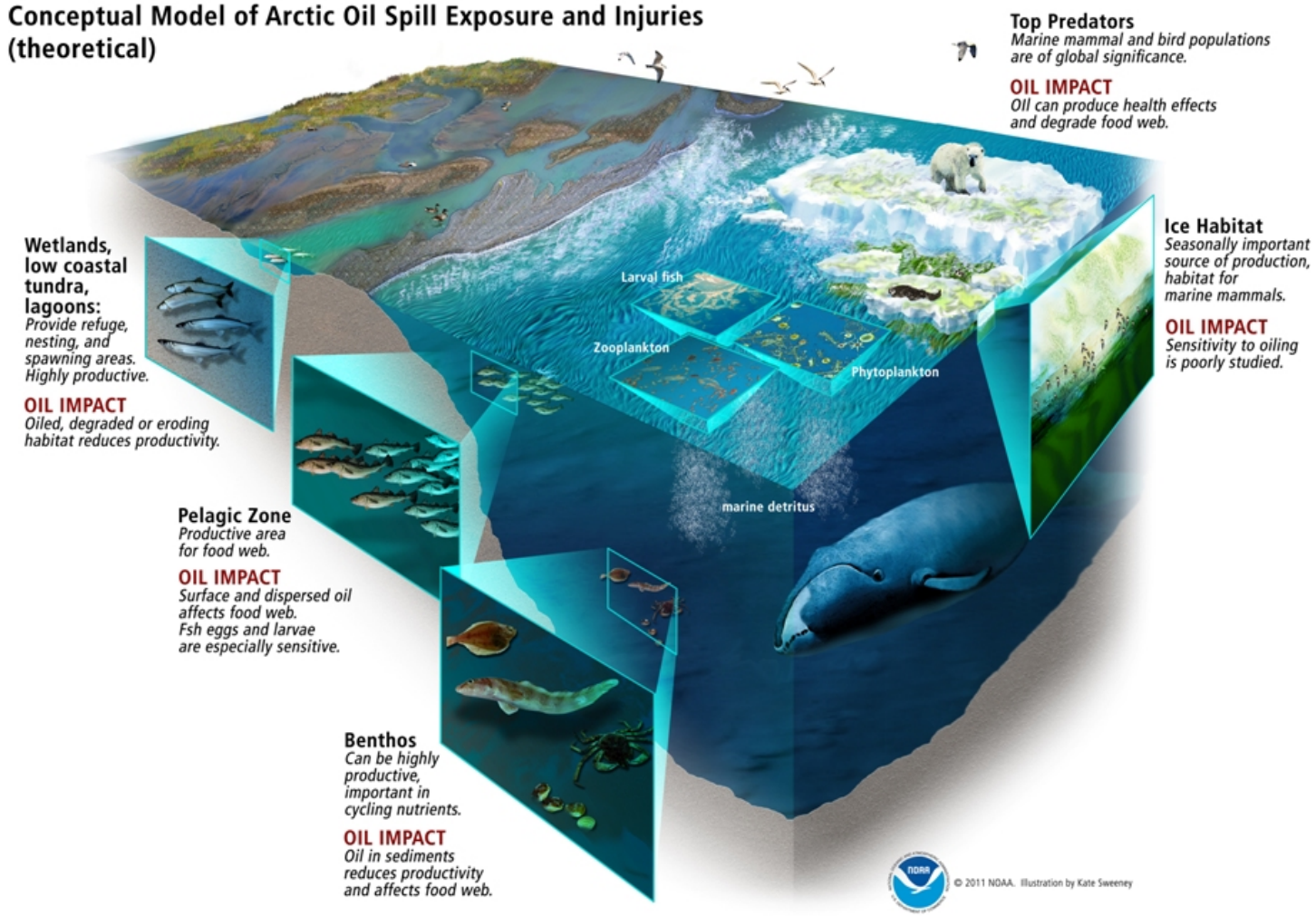
Forecast Challenges and Limited Resources

Arctic Ecosystems



NOAA Arctic Test Bed

Forecast Challenges and Limited Resources

Climate Change

Climate Change Impacts Due to Shorter Frozen Season

- *Altering size and distribution of plants and animals*
- *Coastal erosion threatening villages and facilities*
- *Ecosystem instability*
- *Increased greenhouse-gas emissions from melting permafrost*
- *Increased tundra fire activity*
- *Increase in mining, fishing, and shipping*
- *Altered subsistence activities and critical social needs*
- *Limited season and location for ice roads*
- *Fewer days during which the oil and gas industry can traverse frozen ground on the North Slope*

NOAA Arctic Test Bed

Forecast Challenges and Limited Resources
Current Science and Technology Gaps

- In situ observations (e.g., wave, ocean, and ice buoys, weather observation platforms, river gauge) are scarce in the Arctic.
- Related to these observational gaps, numerical weather, water, ocean and wave prediction models perform worse in the Arctic region as compared to the rest of the US.
- Sea ice modeling capabilities are far from mature.
- Weather, water, ocean and wave, and sea ice forecasting in the Arctic continues to be very challenging.

NOAA Arctic Test Bed

Objective

Develop useful products and delivery mechanisms to communicate current and forecast weather, climate and sea ice information with associated marine and coastal impacts including surge, inundation, and Arctic storms to enhance decision making among Arctic customers and stakeholders

A partnership project between NOAA National Weather Service (NWS) – Alaska Region, NOAA Oceanic & Atmospheric Research (OAR), NOAA NESDIS, University of Alaska Fairbanks, National Snow & Ice Data Center

NOAA Arctic Test Bed

Overarching Benefits

- Address national, NOAA and NWS goals in the Arctic
- Provide input to Arctic Report Card
- Partner with, and leverage ongoing NESDIS Satellite Proving Ground activities as well as other NOAA Test Beds and Proving Grounds
- Formalize collaboration and coordination with other federal agencies with similar goals (e.g., BOEM, USACE, USGS, DOE, USCG , FAA) as well as other NOAA line offices
- Provide direct and meaningful partnership with stakeholders such as the Alaska native communities and tribal councils
- Provide input to science-based decision-making and adaptive planning guided by ongoing research and monitoring

NWS Alaska Arctic Test Bed Potential Partners

NOAA Arctic Test Bed

Decision Support Gaps to Solve

Sea Ice Operations

Ice Shoves, Shorefast breaking
Freezing Spray Potential (Power Outage Savoonga)
Nome Fuel Re-Supply (Supply Chain Mgmt)
Storm Surge interaction (ice/no ice)
Seasonal/Interannual Outlooks (Melt Out/Freeze)

Strategic/Tactical Planning

Messaging – (i.e. Support work with indigenous communities and develop multi-lingual, and culturally relevant services)
Role of Social Media
Outreach

NOAA Arctic Test Bed

Decision Support Gaps to Solve

Climate Operations

Provide Alaska portion of Arctic Report Card

Seasonal/Interannual Outlooks for sea ice, river runoff, spring breakup, sea level, etc.

Climate Change Impacts Planning

Water Operations

Breakup Planning

Coastal Inundation

Surge Forecasting

Wave Forecasts in Sea Ice

Influence of river outflow on inundation and ice

NOAA Arctic Test Bed

Test Bed Guidance

Leveraged from the Joint Hurricane Test Bed (JHT):

- *Identify techniques, models, observing systems, etc. with potential for improving forecast guidance to aid in decision making.*
- *Establish and maintain an infrastructure to facilitate the modification and transfer of research applications into the operational environment.*
- *Complete tests in a quasi-operational environment of tools, techniques, etc. provided by funded researchers, with metrics for scientific performance, ease-of-use, and time constraints.*
- *Prepare documentation, training, and performance evaluations of successfully transferred products to facilitate use and support in operations*

NOAA Arctic Test Bed

Initial Project Activity

Action:

Formulate a Test Bed plan to improve Marine, Weather, Climate and Sea Ice forecasting decision support capability to meet expanding needs in the Arctic

Focus*:*

Sea ice forecast capability is the most critical aspect

Deliverables:

Develop delivery mechanisms to communicate to external stakeholders the current and forecast state of sea ice coverage and weather impact from this phenomena including storm surge, arctic storms, sea ice extent and movement

NOAA Arctic Test Bed

Project Outcomes

- Synergy with ongoing NOAA activities in the Arctic (e.g., NOAA UAS Program, Satellite Proving Grounds)
- Improved operational sea ice forecasting capability
- Improved understanding of sea ice processes
- An understanding of how key Arctic stakeholders use enhanced sea ice forecasts in decision-making
- Enrichment of the NWS Alaska Region Impacts Catalog
- Meets NOAA and NWS goal for the Arctic